NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT

SUBMISSION

TO

URANIUM INQUIRY - NOVA SCOTIA

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MINISTER

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DEPUTY MINISTER

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1.0 INTRODUCTION

The following submission is intended to summarize the Nova Scotia Department of the Environment's perception of the principal environmental issues, management responsibilities and concerns associated with uranium mining and milling.

This submission outlines a number of generally acknowledged issues respecting the potential for contaminant releases and available pollution control measures, and specific Nova Scotia environmental factors which must be considered when assessing the environmental effects of a uranium mine-mill facility.

Also included is a discussion of the Nova Scotia Department of the Environment's legislative mandate for involvement in the general area of environmental management and pollution control. Current regulatory and non-regulatory mechanisms utilized to effect this mandate with respect to major developments such as mining operations are described. Finally, specific management concerns associated with the respective responsibilities and practices of the Department of the Environment and the Atomic Energy Control Board are identified.

The Nova Scotia Department of the Environment neither supports nor rejects the concept of uranium mining and milling in Nova Scotia but recognizes that a number of important environmental issues need to be addressed prior to any decision to proceed with uranium mine development in this Province. Issues identified in this brief focus on outstanding pollution control questions,

current management practices and the critical influence of site specific capacities to attenuate and control contaminant releases over the long term. Ultimately the environmental acceptability of any given uranium mine proposal should depend upon the answers generated by both, regulatory agencies and the mine proponent, to questions raised in these three areas.

2.0 CONTAMINANT SOURCES AND ENVIRONMENTAL CONTROLS

A number of potential environmental effects associated with uranium mining activity may be considered common to most base metal mining operations. While this similiarity does not eliminate their potential for adverse environmental impacts it has allowed for the development of adequate pollution control technologies and management practices. Such 'general' environmental issues include, heavy metal leaching, acid mine drainage and mine site land alterations.

The principal issue which serves to differentiate uranium mining and milling from any base metal operation is the radioactivity associated with the ore, and more specifically, releases of radionuclides during the operational phase, and continuing releases of radionuclides to the environment from abandoned waste rock and tailings areas after shut-down. Current pollution control systems and active management practices appear capable of ensuring that these releases remain within established environmental and health standards. Given the long half life of a number of parent radionuclides however, (e.g. Thorium-230, 80,000 yrs.; Radium-226, 1,620 yrs.) these measures must eventually give way to natural environmental systems for the

ultimate control and attenuation of contaminant releases from the low level radioactive wastes left after mine close-out. Whether or not these standards and natural systems are adequate to protect the environment in Nova Scotia will depend in large part upon the natural conditions at specific mine sites.

Potential contaminant sources and available environmental controls are discussed under the various phases of uranium mine-mill development i.e. exploration, operation and abandonment. Although these are frequently not discrete elements within a uranium mining program they provide a convenient framework for discussion.

2.1 Exploration

The environmental effects associated with uranium exploration activity (e.g. trenching, line cutting, drilling) are not considered to be significant when appropriate pollution control measures are followed. Support for this position may be found in the conclusions of a number of formal inquiries into uranium mining, notably the British Columbia Royal Commission of Inquiry, Health and Environmental Protection, Uranium Mining (Bates Commission).

Failing adequate supervision and control however, two specific environmental concerns emerge: the potential for increased radon emissions from open trenches and the possible contamination of groundwater supplies as a result of interaquifer communication along drill holes.

Currently in Nova Scotia, environmental control of uranium exploration

activity is exercised through the issuance of special uranium exploration licences. As a condition of licence, companies are required to conduct both pre and post exploration radiological surveys, infill trenches, and cement grout drill holes. Additional requirements and details of the present environmental management approach adopted by the Province for exploration activity are presented in the latter half of this submission and in Appendix I.

2.2 Operation

Monitoring data for Canadian uranium mine-mill facilities demonstrate that available technology and management practices can effectively control most emissions and effluents associated with the operational phase of the uranium mining cycle. Notwithstanding this general capability however, concern has been expressed over the following specific issues:

(1) The control of nitrogen compound releases (NH_3 and NO_3) from mining and milling operations;
(2) Total (dissolved and particulate) radium concentration levels in effluents from mines and tailings;
(3) Radionuclide seepage from tailings impoundment areas, and;
(4) The release of radon gas and airborne radioactive particulates from tailings impoundments.

2.2.1 Nitrate and Ammonia Releases

Ammonia (NH_3) and nitrates (NO_3) are contained in minewater as a

result of blasting operations and in mill effluent as a consequence of the nitrogen compounds used in the milling process adopted for most Canadian mines. Concern originates with the fact that past pollution control measures have largely failed to deal with nitrogen compound releases. The environmental significance of these releases centres on two specific impacts (i) un-ionized ammonia is toxic to aquatic biota at relatively low concentrations (safe concentrations are given as 0.02 mg/L) and (ii) elevated concentrations of nitrate may contribute to eutrophication in surface water bodies.

Since the late 1970's extensive research has been directed toward this problem and a number of alternative milling processes have been designed which promise to significantly reduce the level of nitrogen compounds in mill effluents.

Whether such alternative milling methods need be considered for proposed uranium mining and milling operations in Nova Scotia will depend upon site specific studies of receiving water characteristics. It is worth noting, at least with respect to nitrate releases, that it is doubtful this would have a significant effect upon most surface water bodies in Nova Scotia. It is generally conceded that nitrate enrichment is not the limiting factor for eutrophication in many parts of the Province .

2.2.2 Radium Removal

Canadian uranium mines are unique in North America because of the

necessity to release large volumes of effluent from the tailings areas. Effluent releases from the tailings basin may exceed five tonnes (5.5 tons) of water for each tonne of ore processed. Because these effluents often contain radium-226 activities up to two orders of magnitude above the Federal standard of 10 pCi/L (dissolved) some form of radium-226 removal must be practiced.

The method currently employed for the removal of radium-226 from liquid effluents is coprecipitation with barium sulphate. However despite allowances for long settling times, substantial releases of the $Ba(Ra)SO_4$ precipitate to surface waters occur. For example, total radium-226 released may frequently be ten times the activity of soluble radium in an effluent. Concern has been expressed over the presence of $Ba(Ra)SO_4$ precipitate in settling pond discharges since it is soluble at the lower sulphate concentrations encountered in receiving waters.

In recognition of this concern a joint government/industry program for the removal of radium-226 from mining effluents was initiated in 1978. As part of this program a pilot plant study, carried out at Rio Algom's Quirke Lake Mine in the Elliot Lake area, has successfully produced effluents containing less than 10 pCi/L total and less than 3 pCi/L dissolved, radium-226.

It is worth noting that incentive for the application of this or similiar technologies in Nova Scotia may be lacking, given the absence of any specified limit for total radium by Federal regulatory agencies. Failing action in this area by either the Atomic Energy Control Board or Environment Canada one possible option open to Nova Scotia would be the establishment of a Provincial standard for total radium. It is significant that such a requirement by the

province of Saskatchewan for Gulf Minerals' Rabbit Lake Mine has resulted in effluents with consistently less than 10 pCi/L total Radium-226.

2.2.3 Seepage from Active Tailings Areas

Contaminant seepage into groundwater systems beneath tailings impoundment areas stands as a potential problem with any mine waste disposal system in temporate climates. In Canada, current practice for uranium tailings seepage control relies upon containment and the use of liners (geological, clay or synthetic). Because all liners possess a finite permeability, seepage losses are an inescapable fact. Futhermore, all artificial liners may be subject to improper installation and, over the long term, possible rupture and degradation.

Therefore, the success of any seepage control system will depend upon a number of factors:

(1) a clear understanding of foundation conditions to both dilute and remove contaminants, thereby ensuring that design seepage rates and volumes are adequately controlled.

(2) in the case of a reliance upon artificial liners to achieve these design rates, careful attention to planning detail and installation procedures will be required.

(3) and finally, adequate monitoring and contingency planning to ensure that excessive seepage may be discovered and remedied.

2.2.4 Atmospheric Emissions from Tailings

Radon emissions from mine ventilation exhaust and tailings areas and radioactive particulates from milling operations (yellowcake handling and drying) and tailings constitute the principal atmospheric emission sources for uranium mining and milling facilities. Of these sources, tailings impoundments are usually acknowledged to be of particular concern both because of the level of radon releases (e.g. 100-650 Ci/sec for a typical tailings area v.s. 50-100 Ci/sec for mine ventilation exhaust)* and their capacity to act as a source for radon and radioactive particulate emissions after mine close out and abandonment.

Radon Releases: Based on theoretical calculations of the expected radon flux and rate of atmospheric dispersion it has been determined that the average radon concentration at a distance of 1-2 km from a typical tailings area would be indistinguishable from background levels. The theory is supported by limited monitoring data in the Elliot Lake area.

While offering confirmation that background concentrations are acheived within relatively short distances, empirical measurements in the Elliot Lake area have also served to indicate that radon concentration levels above tailings impoundments may range up to 10 pCi/L. The present Canadian Federal

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* Data obtained from measurements of tailings areas and mining operations in the Elliot Lake area.

standard for public exposure is 0.02 WL which roughtly corresponds to a radon concentration of 4 pCi/L*.

During mine operation effective isolation of tailings areas is achieved through access restrictions. Following abandonment and the cessation of active supervision however, such isolation may be difficult to realize. Consequently, close-out measures to ensure that radon concentration limits do not exceed public exposure standards, within the immediate vicinity of tailings areas will be required.

It is worth noting that a number of studies conducted in the United States have concluded that a moist soil cover of 3 metres would be adequate to reduce the radon emission rate from most tailings impoundments in the U.S. southwest, to the Nuclear Regulatory Commission's recommended flux rate of 2 pCi/m^2/S (approximately 2 X background).

Particulate Releases: Dust suspension and transport have not been studied extensively in Canada. Nevertheless the potential for this mode of radionuclide transport has been estimated, using data on tailings particle size distribution, particle suspension, and models of atmospheric transport. Concentration levels derived in this manner have demonstrated general agreement with field measurements obtained in the United States southwest.

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* Assuming an indoors equilibrium factor (100 X WL/Rn concentration in pCi/litre) of 0.5 for radon and its daughters.

These estimates show that insignificant fractions of the $MPC_{(a)}$ * would occur for all radionuclides except the thorium isotopes which would approximate 25% of $MPC_{(a)}$, in the immediate vicinity of the tailings site.

Based on these calculations and the wet conditions which prevail, dust dispersion, at least over the short term, is not usually considered to be a significant factor in Canada. Measures will be required however, to ensure that long term erosion processes will not pose a problem.

Tailings re-vegetation is generally proposed as the principal long term erosion control measure. Problems cited with this approach include increased radon releases through leaf exhalation and radionuclide uptake by the vegegetative cover and possible subsequent incorporation into the food-chain. Research into the potential significance of these transport mechanisms is required.

2.3 Abandonment

The most significant concern associated with the uranium cycle relates to the long term stability of the tailings and more specifically the rate at which abandoned tailings will release contaminants to the open environment. While active management schemes may be used to maintain the emissions from

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* $MPC_{(a)}$ - Maximum permissible concentration in air for continuous exposure as recommended by the International Commission on Radiological Protection (ICRP).

inactive tailings areas within regulatory limits, the steps required for the safe total abandonment of these sites are not yet known.

Following the cessation of mining and milling operations and active tailings management a number of specific problems have been identified which could contribute to unacceptable contaminant releases:

(i) Alteration of tailings water chemistry over a long period of time could result in increased seepage and leakage and mobility of such radionuclides as radium and thorium. The possibility for increased mobility of these contaminants over time is largely attributable to the potential for a reduction in tailings water pH, either as a result of oxidation of pyrite present in some tailings or acid precipitation.

(ii) Redissolution and release of radium from barium radium sulphate sludges in treatment ponds. Radium leaches from treatment pond sludges when in contact with water low in sulphates. Consequently, over an extended period of time precipitation and surface runoff entering inactive radium treatment and settling ponds could remobilize this radionuclide. Because of this potential for radium releases, it is acknowledged by the AECB that precipitation ponds are not suitable for the final disposal of these sludges. Options which have been suggested for sludge management include underground placement either in worked-out mine areas or in special chambers, or placement in the tailings areas. The latter alternative has frequently been suggested as the preferred option, however further

research is required to ensure confidence in this mode of disposal. Quantitative data is lacking both on the effect of physical and technical conditions in tailings on the resolubilization of radium from precipitated sludges, and on the fraction of this additional radium which would be released.

(iii) Tailing impoundment dam failures and physical erosion and transport of tailings. Impoundment dam failures have occurred in the past but improved design and construction techniques have significantly lowered the probability of future failures. Similiarly, improvements in site selection criteria and tailings surface stabilization practices have largely eliminated large scale erosion concerns, at least for the short term. Over the long term however, i.e. thousands of years, erosion and transport of tailings is inevitable. Ultimately the significance of these processes will depend upon proposed measures to reduce the radionuclide content of tailings (discussed below), the rate of contaminant release and environmental bio-physical conditions in the vicinity of the disposal site.

As indicated, the supervision and management of abandoned tailings areas can provide reasonable assurance that any contaminant releases remain within regulatory limits. The problem originates with the fact that "walk-away" requirements have yet to be defined for the concerns outlined above and institutionally based management schemes will not be capable of dealing with these issues for anything approaching the time period over which tailings areas will continue to remain mildly radioactive.

Under current practices 85% of the total radioactivity contained in the ore is discharged with the tailings which may be expected to contain about 5% of the uranium originally present and more than 99% of the radium-226 and thorium-230. Given the slow decay rate of radium and thorium and typical concentration levels in mill effluent discharged to tailings (2-3,000 pCi/L total radium-226 and, 70,000-360,000 pCi/L total thorium-230), by present standards the level of activity after 100,000 years would still be too high not to require isolation.

Recognition of this problem by both industry and government has spawned research into a variety of possible solutions ranging from the removal of thorium-230 and radium-226 during the milling process, to the determination of environmental conditions, i.e. site selection criteria, appropriate for the natural and safe dispersion and attentuation of tailings contaminants. Confidence by the Atomic Energy Control Board that the necessary steps for the safe total abandonment of tailings will be determined within the near future, is presented as its principal justification for allowing new uranium mine-mill facilities to be developed.

Any prediction of the time required to address this problem must remain speculative. However, the National Technical Planning Group on Uranium Tailings* has recently estimated that a time period "in excess of a decade" will probably be required to complete the necessary research and development work for this task. In the event uranium mining proceeds in Nova Scotia prior

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* Sponsored by the Canada Centre for Mineral and Energy Technology (CANMET). The Group was formed in 1980 and consisted of representatives from the Provincial and Federal governments including regulatory agencies, the uranium producers, universities and provincial research organizations.

to the definition of effective long term disposal techniques, tailings site selection and close-out procedures must be based on the assumption that the natural environment will act as the ultimate guarantor for effective pollution control. Such an assumption will require a clear understanding of the significance of long term natural processes and site specific air aquatic and terrestrial pathways for contaminant transport. A number of specific conditions which must be considered and carefully evaluated are presented in the following section.

3.0 NOVA SCOTIA-ENVIRONMENTAL CONSIDERATIONS

The following discussion is intended to briefly outline a number of specific environmental factors which must be considered when assessing the potential for offsite contaminant transport and environmental effects of uranium mining and milling in Nova Scotia. These factors are presented under two headings: Aquatic Pathway and Atmospheric Pathway.

Land use considerations indicate that the necessity to understand radionuclide transport along aquatic and atmospheric pathways may assume particular significance in this Province. Unlike other uranium producing areas in Canada, such as northern Ontario and northern Saskatchewan, exploration targets in Nova Scotia have frequently been located near existing populated areas and productive agricultural land. For example, the uranium occurrence near Palmer Lake (Kings County) is situated within 16 km of the Kingston-Berwick area, an important dairy and vegetable farming area. The population density within a 16 km radius of Palmer Lake is estimated to be

about 170 persons/km^2. A dramatic contrast to this situation is provided by the uranium producing areas of northern Saskatchewan where, aside from the mining industry, land use activity is largely restricted to hunting, trapping and fishing by a relatively small and widely scattered population. For example, the population density within a 40 km radius of the Rabbit Lake mine is estimated to be approximately 0.1 persons/km^2.

3.1 Aquatic Pathway

Two conditions which could influence contaminant movement into the aquatic pathway and therefore must be considered in the design and siting of waste disposal systems are, the high annual precipitation rate and the limited surficial cover which characterizes much of Nova Scotia's landscape.

High precipitation (140 cm in Nova Scotia v.s. 79 cm in Elliot Lake and approximately 40 cm in northern Saskatchewan) could increase the potential for offsite contaminant transport as a consequence of three factors:

(i) an increased likelihood that tailings impoundments will intersect the water table;

(ii) a higher mine water infiltration rate than experienced by other uranium producing areas; and,

(iii) an increased potential for erosion of abandoned tailings area over the long term.

Much of the granitic terrain in Nova Scotia is overlain by thin (less than

1.5 m) highly permeable deposits of sandy glacial till which contain relatively low concentrations of carbonate (.02 - .1%) and exhibit a low cation exchange capacity, generally less than 10 millequivalent/100g as compared to over 100 meq/100g elsewhere in Canada. Such material would have a poor capacity to attenuate or immobilize contaminants leached from a uranium tailings disposal area or from waste rock piles.

3.1.1 Groundwater

In most potential uranium mining areas of Nova Scotia (e.g. South Mountain Batholith) groundwater movement occurs along fractures in the rock (fracture permeability). In general, failing extensive subsurface drilling, water movement in fracture flow systems is difficult to predict and consequently difficult to monitor. An additional problem originates with the limited chemical attenuation characteristics of these systems. Finally, due to the limited relief and the general predominance of vertical fracturing and exfoliation permeability, local (shallow) flow systems are likely to predominate in Nova Scotia with consequent rapid discharge to the surface in springs, streams or wells within relatively short distances. These conditions raise the prospect that any contaminants leached to the groundwater system will not only be difficult to follow but may be transported in large part rapidly to the surface.

The potential contamination of fracture flow systems is considered to be an important issue in Nova Scotia since, unlike most other regions of the world, fractured crystalline aquifers act as a source of water for

approximately 70% of the Province. Therefore a detailed site specific and regional investigation of the hydrogeology and hydrogeochemistry, designed to investigate the significance of this pathway, should be conducted prior to any descision to establish a mine or tailings impoundment.

3.1.2 Surface Water

High runoff rates, combined with hard insoluble bedrock and well leached soils over much of the Province, provide little opportunity for surface flow to become enriched in dissolved minerals. The result of this combination of factors is that Nova Scotia waters have been observed to be among the most dilute in the world. A second important feature of many of the Province's lakes and streams is that while they may have few dissolved minerals, they do often contain varying concentrations of brown coloured humic substances. Finally, these waters characteristically exhibit slightly acidic pH values.

Low alkalinities, attributable to low concentrations of alkali earth metal ions, and acidic pH values in many of Nova Scotia's lakes and streams suggest these waters have little or no buffering capacity and hence are prone to further pH depression. Although technology exists to adequately control the pH level of effluents discharged from active mining operations it is noted that seepages from a number of inactive tailings areas in northern Ontario have exhibited pH readings as low as 2. Such low pH's are directly attributable to high iron sulphide concentrations in the ore and may therefore not be indicative of conditions encountered in this Province. In the event pyrite mineralization is associated with uranium ore bodies in Nova Scotia

however, this experience suggests that pH adjustment of tailings may have to be continued following mine close-out. Potential impacts associated with acidic discharges would include; mortalities to freshwater organisms as a result of pH shock; and elevated concentrations of metals leached from surface water sediments.

A second consideration originates with the frequent high concentrations of organic substances in Nova Scotia waters. Organic molecules are known to sequester metals and other substances, frequently altering both their relative toxicity and mobility, however the effect of organic substances on radioactive elements is poorly understood. Studies specific to the Nova Scotia setting will be required therefore, to better understand the potential role played by humic substances in the complexing and transport of metals and radionuclides.

The necessity for a detailed assessment of surface water and contaminant (both regulated and unintentional releases) interaction is apparent when it is realized that many of the surface water systems which supply water to large parts of Nova Scotia originate in the highland areas where uranium projects are now being evaluated.

3.2 Atmospheric Pathway

As indicated, estimates of ground-level concentrations of airborne radioactive releases from uranium mine-mill facilities have generally been based on calculated emission rates and atmospheric modelling.

Such modelling as applied to both Canadian and U.S. operations has usually assumed steady state conditions, flat homogeneous terrain and homogeneous wind flow. While perhaps appropriate for the inland shield areas of Canada, i.e. predictions are supported by limited field data, it must be noted that winds characteristically change more rapidly both with respect to time and space in coastal areas than they do inland. Furthermore, homogeneous wind flow is generally considered to be an invalid assumption in coastal regimes. Coastal winds show marked variability and even over uniform terrain vertical changes in stability frequently develop.

In order to predict airborne transport and subsequent ground concentrations of radon and radioactive particulates it will be necessary to ensure that atmospheric dispersion models adequately reflect the maritime climate conditions and uneven topographic characteristics of Nova Scotia.

4.0 NOVA SCOTIA DEPARTMENT OF THE ENVIRONMENT LEGISLATIVE MANDATE, RESPONSIBILITIES & ACTIVITIES

The mandate of the Nova Scotia Department of the Environment is to ensure that all practical measures are taken to preserve the environment from deterioration and to provide the best use of renewable resources for the benefit of the people of the Province. The Department, in its present form, exercises this mandate through a mix of regulatory and non-regulatory functions. Regulatory programs such as those of Industrial Waste Control and Water Rights, while establishing their own management prescriptions through permitting and approval procedures, are complemented and supported by the

environmental data collection, interpretative capabilities, and planning and inter-agency coordinative activities associated with the non-regulatory programs.

4.1 Regulatory Role

The Nova Scotia Department of the Environment administers five separate Acts. Only two of these however, are expected to have any direct significance with respect to uranium mining, the Environmental Protection Act* and the Water Act+. These Acts give the Minister responsibility for authorizing: the use or alteration of any watercourse in the Province (Water Act, Sections 3 and 18); the control of sewage and water works (Water Act, Sections 13 and 14); and the environmental conditions under which any plant, structure, facility or undertaking may be developed and operated (Environmental Protection Act, Section 28). A copy of each Act, together with a brief discussion of purpose, special features and enforcement provisions is provided in Appendix A.

4.2 Non-regulatory Functions

The non-regulatory functions of the Department may be broadly divided into two categories: inter-agency coordinative activities; and environmental data collection and interpretation.

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* Environmental Protection Act, S.N.S. 1973, c.6, as am. by S.N.S. 1975, c.66.

\+ Water Act, R.S.N.S. 1967, c.335, as am. to 1972, c.58.

The Environmental Protection Act empowers the Minister to "coordinate the work and efforts of departments, boards, commissions and offices of the Province respecting any matter relating to the preservation and protection of the environment." (Section 8 (1)(b)). In exercising this mandate the Department actively involves Provincial agencies and departments in its permit approvals process and environmental assessment programs, and has established a number of inter-departmental committees to address specific environmental issues. The joint Mines and Energy/Environment Technical Committee constituted to incorporate environmental concerns into the Mines and Energy licensing process for uranium exploration, provides an example of this role.

The second non-regulatory function that may be relevant to uranium mining is largely concerned with the establishment of standards and the collection and interpretation of environmental and resource data. These functions are embodied in the Assessment, Water Planning and Management and Inspection and Monitoring Divisions of the Department, and include such programs as: ambient air quality monitoring; environmental baseline data collection for major development proposals; surface and groundwater inventory; and planning and development of programs pertaining to solid and hazardous waste management.

In order to perform these functions qualified scientific and technical staff have been acquired by the three operational Divisions of the Department, with expertise in a range of fields which include, industrial pollution abatement and related engineering technology, waste water engineering, hydrogeology, limnology, environmental planning, impact assessment, and air quality control and monitoring systems. Under the Environmental Protection Act the Minister is empowered to augment this staff capability as required, by

engaging contract employees, consultants and the support of other government agencies. Details of the organization and programs having relevance to mining activities for each of these Divisions, are included in Appendices B, C, and D.

4.3 ENVIRONMENTAL REVIEW AND APPROVALS PROCESS

As revealed by the discussion on mandate and responsibilities, any new uranium mine-mill facility will require approval by the Minister of the Environment prior to the commencement of construction. Technical review of all phases of a proposed project (construction, operation and abandonment) and related pollution control systems is conducted as a normal part of the Department's approval process. This review is expanded to include a requirement for an environmental impact assessment for projects considered likely to have a significant effect on the environment or where the potential exists for major resource-use conflicts.

4.3.1 Environmental Impact Assessment

The statutory basis for requiring environmental impact assessments is provided in two acts administered by the Nova Scotia Department of the Environment: the Environmental Protection Act and the Water Act. While a formal policy and administrative procedure governing environmental impact assessments has not been adopted by the Province, the Department's assessment process normally includes the following major elements.

The proponent is requested to submit an overall project description for review by the Department. This initial project review is used to determine whether the project needs to be subjected to an environmental impact assessment process.

In cases where an impact assessment is required, project specific terms of reference (guidelines) are prepared for an environmental impact statement (E.I.S.). Frequently the proponent is requested to provide additional information on the project and surrounding environment (an environmental overview) in order to facilitate the preparation of these guidelines.

E.I.S. guidelines are prepared by a technical inter-departmental and/or inter-governmental review panel under the direction of a staff coordinator appointed from the Assessment Division. Consultation with the proponent during guideline preparation constitutes an integral part of this process.

The proponent, directed by the project-specific guidelines, then undertakes the required studies on the physical and biological environment and the impacts on those environments are forecast.

When the E.I.S. is completed it is submitted to the Department and reviewed by the technical review panel. If the statement is deemed to be free of deficiencies a review document is prepared including recommendations regarding the environmental acceptability of the proposed project, and submitted to the Minister.

The Minister, in consideration of the impact statement, the review document and any comments from the public, may decide:

(a) the project is environmentally acceptable and the proponent may make application for approval;

(b) the project is not acceptable;

(c) additional information is required;

(d) the project is acceptable subject to certain terms and conditions. If the proponent accepts the terms and conditions he may make application for approval.

A detailed description of the E.I.A. process and examples of Impact Statement guidelines prepared for mining proposals are presented in Appendices E and F.

4.3.2 Pre-operational Approval

Section 28 of the Environmental Protection Act stipulates that Ministerial approval is required for all proposed undertakings that will or are likely to cause pollution. Consequently, irrespective of any requirement for an Impact Statement, an Industrial Waste Permit Approval for control of all mine and mill effluents is required before such a facility is allowed to operate. Mine water discharge, tailings system design, and effluent treatment systems are examples of items approved by the Department under the Environmental Protection Act.

Additional approvals are required under the Water Act covering: (a) consumptive ground and surface water use, and; (b) sewage treatment systems.

The complication of seeking the numerous approvals noted above is simplified somewhat by the Assessment Division which oversees discussions on all of the above operational approvals and prepares a single approval (Industrial Waste Permit) to cover these aspects.

A separate permit approval is issued under the Water Act for any proposed diversion of surface water around a mine site or drainage of surface water bodies. Although a separate Water Rights Permit is processed by the Water Planning and Management Division the permit approvals procedure is again coordinated by the Department's Assessment Division.

Plans for operational monitoring, abandonment and reclamation of the mine, mill and tailings area would be approved at the same time as the major operational approval is carried out under the Environmental Protection Act. Interagency cooperation is evident throughout all phases of the approvals process. In circumstances where other Provincial and Federal legislation and regulations apply, the Department normally incorporates their requirements into its permit approvals. Similarly, the review of compliance monitoring data, site inspections, and any pollution control studies are conducted in cooperation with appropriate Federal and Provincial agencies.

Copies of Industrial Waste and Water Rights permits and details of the two approval processes are provided in Appendix G.

4.4 Activities Related to Uranium Mining

Since the start of intensive uranium prospecting and exploration activity

in Nova Scotia the Department of the Environment has undertaken to prepare itself for possible developments in several ways.

(a) Baseline Monitoring

In cooperation with Kidd Creek Mines Ltd. (Aquitaine) and the Federal Environmental Protection Service the Department has established a detailed baseline data gathering program for the Millet Brook Uranium Property. Both radiological and non-radiological data have been collected by the Water Planning and Management Division and Kidd Creek Mines Ltd. (Appendix H).

(b) Exploration Control

In 1981 the Department in cooperation with the Department of Mines and Energy developed guidelines for uranium exploration in the Province entitled "Terms and Conditions Governing Special Uranium Exploration Licences" (Appendix I). This document ensures that proposed exploration programs are brought to the attention of the Department, specifies the type of preliminary baseline data which must be submitted, and sets out a code of practice for exploration operations.

The Department has also proposed a draft amendment to regulations under the Nova Scotia Mineral Resources Act, which if adopted would make approval by the Minister of Environment mandatory for all proposed exploration activities in municipal watersupply watersheds.

(c) Participation on the Provincial Uranium Task Force on Uranium in Drinking Water

In October 1979, a Task Force was created to "coordinate investigations on

the occurrence of uranium and related elements in Nova Scotia water supplies". Represented on the Committee are:

Department of the Environment

Department of Health

Department of Mines and Energy

Department of Municipal Affairs

Environmental Chemistry Laboratory, Pathology Department Victoria General Hospital

Specific Nova Scotia Department of the Environment input to this Committee has included: sample collection; data interpretation; and hydrogeologic studies.

(d) Initiation of a Uranium Research Program

In the fall of 1981 an inter-divisional committee on uranium mining was formed to advise the Department on the environmental hazards associated with uranium mining and exploration, and related management issues and requirements. Specific tasks undertaken by the committee include:

(i) the collection of a comprehensive library on pollution and environmental control associated with exploration, uranium mining and processing and tailings disposal practices, as well as reports of all known uranium public inquiries held in Canada and elsewhere. A complete bibliography is given in Appendix J, and the Inquiry is invited to make use of this material.

(ii) the preparation of technical reports on the following topics:

(1) Jurisdiction over Uranium Mining and Milling

(2) Airborne Effect of Uranium Mining and Milling

(3) Uranium Mining - Nova Scotia Environmental Concerns

(4) Environmental Management Concerns

(5) Review: General Environmental Concerns and Waste Management Practices.

5.0 MANAGEMENT CONCERNS

Under Section 17 of the Atomic Energy Control Act*, uranium mining and milling facilities are declared to be works for the general advantage of Canada. Administrative responsibility for the Act was given to the Atomic Energy Control Board (AECB) which was empowered to make regulations respecting mining and prospecting for radioactive materials.

Notwithstanding the scope of the Atomic Energy Control Act, and the apparent jurisdiction of the AECB over all aspects of atomic energy, provinces have (to varying degrees) instituted mechanisms for managing exploration and mining activities. In practice the AECB appears to have accepted the principle that environmental management of uranium mine-mill operations is a joint federal-provincial responsibility; characterized by one commentator as an arrangement which constitutes a de facto state of concurrent jurisdiction,

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* Atomic Energy Control Act, R.S.C. 1970, c.A-19, as amended.

while preserving a de jure state of exclusive federal jurisdiction. Thus, it is not surprising that provincial environmental management concerns spring from two sources: the manner in which the AECB perceives its mandate and implements its responsibilities, and the jurisdictional aspects of the regulatory process. Specific areas of concern identified by this Department include:

(1) Exploration control

(2) Impact Assessment Process

(3) Standard Setting and Monitoring

(4) Regulatory Enforcement

(5) Long term tailings management

5.1 Exploration Control

The Atomic Energy Control Board's mandate under the AEC Act includes the right to regulate prospecting. In practice however, the Board has limited its involvement at this stage to the issuance of an Ore Removal Permit, if and when the 10 kg. of thorium or uranium ore in a concentration exceeding 0.05% grade, are removed within one calendar year.

As a consequence of the AECB's restricted interpretation of its mandate, environmental management responsibility for this phase rests with the Province.

Specific management concerns centre on three issues:

(1) a mechanism to ensure programs are brought to the early attention of the Department,

(2) the environmental evaluation and control process,

(3) and the inspection and enforcement capability for pollution control measures.

To date the Department has elected to address the first two issues through the mechanism of a "terms and conditions" document issued with all uranium exploration licenses. With respect to the third management issue, the Department is commited to ensuring that all environmental requirements are met by the industry. To this end, monitoring of exploration programs has been carried out in cooperation with staff from the Department of Mines and Energy.

Concern has been expressed to this Inquiry about the enforcement of the "terms and conditions" governing exploration activity because they have not been proclaimed as regulations under an Act. Under the current procedure, special uranium exploration licences are issued as Orders in Council under the Mineral Resources Act*. Consequently, such penalties as provided in that Act would apply, given non-compliance with licence conditions. In the event a failure to comply with the "terms and conditions" results in pollution, an additional enforcement capability exists under the Environmental Protection Act.+

5.2 Impact Assessment

The Atomic Energy Control Board has established a requirement for an Environmental Impact Statement before construction and development may

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* Mineral Resources Act, S.N.S. 1975, C.12.
\+ See Section 26, Environmental Protection Act

proceed; however, it has not defined specific content requirements nor has it clearly established an assessment process. Notwithstanding the issuance of an AECB Regulatory Guide respecting public information programs for proposed uranium developments, the absence of a well defined process leaves uncertain the extent and nature of public participation in impact study design and review.

In practice however, the AECB has elected to rely upon established provincial assessment procedures. Consequently the opportunity exists for comprehensive public involvement within the Provincial process. This activity is explicitly authorized under Section 17(2) of the Environmental Protection Act which empowers the Minister to authorize the Environmental Control Council to hold public hearings.

It must be noted however, that a flexible Provincial policy on impact assessment has in turn contributed to flexibility in the Department's requirements for public input. To date the Department's approach has varied significantly, ranging from formal public hearings conducted by a joint Federal/Provincial Assessment Panel to a simple release of the final impact statement for public information. Thus, public participation has not been rigidly defined within the process.

5.3 Standard Setting and Monitoring

While the establishment of standards for uranium mining is dependent upon adequate research, it is also dependent upon acceptance of the

standards by government and their introduction either as regulations or as conditions of licence.

It has been the practice in other areas of shared federal-provincial responsibility for environmental management (i.e. Clean Air Act, and the Environmental Contaminants Act) that the Federal Government establishes minimum standards. This is generally done in consultation with the provinces who may wish to introduce more stringent standards. It is not clear, however, that this model of environmental management will also apply in relations between the AECB and the provinces with respect to uranium mining. This uncertainty originates with the mandate granted the AECB under the AEC Act; and its apparent reluctance to include standards in its licences significantly different from those it has traditionally imposed on the industry. This assumes particular significance in light of our concern that contaminant release limits must reflect Nova Scotia environmental conditions.

The provincial response to this issue has varied according to the general position of the particular government on the question of jurisdiction. Saskatchewan has taken the position that it has at least concurrent jurisdiction and has drafted its own Uranium Mining Pollution Control Regulations. On the other hand, Ontario has assumed jurisdiction rests with the Federal Government and has accepted the standards 'adopted' by the AECB. A consequence is that Saskatchewan has established maximum concentration limits for a variety of contaminants , such as thorium-230 and undissolved radium-226, not regulated in Ontario. Rather than establishing a maximum concentration limit, the AECB has elected to apply a principle of "as low as reasonably achievable" (ALARA) for these parameters.

If it is the intention of the Province to pursue an approach similar to that adopted by Saskatchewan and recommended by the Bates Commission, specific receiving water and/or effluent standards will have to be developed for the uranium industry. Furthermore, consideration will have to be given to an appropriate enforcement mechanism. In spite of Saskatchewan's stated position on jurisdiction the Province has considered it necessary to tie its effluent standards to Surface Lease Agreements signed between the Province and individual operators. A section of these agreements ensures that Provincial inspectors have access to leased land and company documents for the purpose of monitoring compliance with its standards. A copy of the Key Lake Uranium Mine Surface Lease Agreement included in the Departmental Uranium Library, is available to the Inquiry.

5.4 Regulatory Enforcement

The Atomic Energy Control Board has traditionally relied on Control Board trained provincial officials to conduct site inspections on its behalf. The officials, who are usually provincial mine inspectors, are licensed as Atomic Energy Control Board Inspectors and as such are empowered to enforce AECB licencing provisions. It is not surprising therefore, that the question of whom the Inspector is representing and the further question of to whom that Inspector is accountable have been raised by both the Bates and Bayda Commissions of Inquiry.

Additional questions are raised by the present situation with respect to the control and enforcement powers of the Province. Notwithstanding the

position adopted by Saskatchewan, the AEC Act casts doubt upon the constitutionality of provincial prosecution on the basis of their own legislation.

Failing a favourable resolution of this issue the Province may be forced to rely upon the Ontario practice of including provincial laws in AECB licensing requirements. Not only is this arrangement cumbersome from a prosecution perspective, but the situation is made even less certain because the AECB licence requires compliance only with all provincial law of general application. Consequently, it is not clear whether the more particular compliance instruments found in the Regulations of such laws also apply.

5.5 Responsibility For Tailings Management

As indicated in the discussion of environmental issues, the long term adequacy of present tailings management practices is in question. Until suitable long term solutions have been developed and are in place there will be a need for both money and operational capability to ensure that necessary remedial work and monitoring will be carried out. At present there is no agency in Canada to whom the custody of waste management facilities can be transferred. However, both the AECB and Energy Mines and Resources Canada have recognized that an assignment of responsibility is necessary and E.M.R. has recently funded a study of possible management options. Given this initiative by the Federal Government it will be in the interest of Nova Scotia to consult with the appropriate federal agencies as soon as possible to discuss both the allocation of management authority and the manner in which it will be exercised.

A final concern centres on the assignment of financial responsibility for post abandonment monitoring and remedial work. Although the AECB has identified a need for an economic guarantee on the part of industry to cover this work, it has not included this requirement in its proposed close-out criteria. While there is no federal mechanism to ensure funds are made available to cover long term management costs, action in this area has been initiated at the provincial level.

The Saskatchewan government has established a one million dollar fund for each new mill opened in that province, specifically to meet any costs associated with post-abandonment remedial work. Whether similar action need be considered by Nova Scotia should depend on the Board's willingness to require some form of economic guarantee as a condition for close-out approval.

In the event the Board does take this initiative important questions relating specifically to the nature of the guarantee and the mechanism for administration will remain. Given the direct influence any fund arrangement will have over monitoring and remedial operations it will be in the interest of the Province to ensure that answers to these questions originate within a joint Federal/Provincial forum. In light of uncertainty over long term responsibility for tailings it is possible to develop a scenario in which supervision could fall to the Provincial Government with financial control held by the Federal Government. Failing provision for an adequate fund level and some control over the disbursement of funds, Nova Scotia may wish to institute its own form of economic guarantee.

6.0 CONCLUSION

A number of potential environmental effects associated with uranium mining such as heavy metal leaching from waste materials and acid drainage, represent problems commonly encountered by the mining industry in general and base metal mines in particular. As such, effective management practices and pollution control technologies have been developed and tested over time in wide range of environments, to deal with these issues.

The environmental issue however, which serves to differentiate uranium extraction from other mining and ore processing operations centres on the radioactivity associated with the ore and more specifically, the release of radionuclides during all phases of mine development and following mine close-out.

Existing pollution control systems and active management practices appear capable of ensuring that these releases meet accepted environmental and health standards. The major environmental issue originates with the post-operational phase and the potential for mine-mill wastes to act as a long term source for radionuclide releases following abandonment. Although active management schemes are used to maintain the emissions from inactive radium precipitation ponds and tailings areas within regulatory limits, all of the steps which may be required for the safe total abandonment of these wastes have not as yet been demonstrated.

Notwithstanding this current state of knowledge, draft close-out criteria proposed by the AECB require acceptance of the principle that the

future bleed rate of contaminants from abandoned waste management sites should not exceed operational levels, without any necessity to rely on continued monitoring to demonstrate that fact. Failing implementation of measures designed to remove thorium and radium from the waste stream, this requirement assigns long term management responsibility for the control of radionuclide releases to the open environment, to natural geochemical and biochemical processes.

The evolution of tailings waste management area and its interaction with the surrounding environment has been generally acknowledged as a very site specific problem. Consequently, the design of any particular program must, of necessity, be quite site specific in approach, taking into account the milling process employed and the site options available for management both as they exist today and as they may be expected to change in the future. These circumstances stress the important role mine location may play in determining the ultimate environmental acceptability of any given uranium mine-mill operation and its associated waste management facility.

In the event uranium mining and milling proceeds in Nova Scotia, a detailed assessment of site environmental conditions should therefore be carried out, with particular emphasis placed on the identification of potential critical pathways. In addition, both the regulating agencies and the industry must be aware of the action required to meet those environmental concerns which are specific to Nova Scotia. Particular issues identified in this brief include:

(1) The high water table and shallow, fracture flow groundwater systems increase the potential for contamination of groundwater and fairly rapid discharge to surface waters. More knowledge of groundwater systems in proposed uranium mining areas is required if this increased potential for contamination is to be evaluated and preventive measures undertaken.

(2) Surface waters in Nova Scotia characteristically exhibit low alkalinities and acidic pH values, indicating they possess a limited buffering capacity and are consequently prone to further pH depression. In the event sulphide mineralization is associated with uranium ore deposits in this Province, measures would have to be instituted to ensure that the pH level of seepages from abandoned waste desposal areas is adequately controlled. Further, the generally high concentration of organic compounds in Provincial surface waters will require investigation of the interaction of organic substances with metals and radionuclides.

(3) Climatic and topographic conditions in Nova Scotia (high annual precipitation, variable winds, non-homogeneous topography) are completely dissimilar to those variables on which existing atmospheric dispersion modelling for radioactive releases is based. It will be necessary to ensure therefore, that such models adequately reflect the Province's climatic and topographic characteristics.

Finally, given the limited understanding of radionuclide movement along specific pathways over time, it will also be necessary to establish a comprehensive monitoring program designed to define those physical processes

and geochemical and biochemical reactions affecting the mobility of radionuclides. This basic understanding of the interaction of natural processes with the waste managment environment should be established as an important prerequisite to any termination of active management.

Pre-operational environmental assessment and regulatory control and monitoring during the exploration, operation and abandonment phases (until such time as walk-away requirements are deemed to be in place) will require the active involvement of the Provincial Department of the Environment.

The Department of the Environment has a wide diversity of interests and responsibilities that can be focused upon the environmental aspects of uranium mining through a combination of environmental assessment and regulation. However, the role adopted by the Province in the regulation and control of the uranium mining industry must take into account the jurisdictional aspects of the regulatory process and the role played by the Atomic Energy Control Board.

Notwithstanding the authority granted the AECB under the Atomic Energy Control Act, in practice the Board has accepted the principle that environmental management of uranium mine-mill facilities is a joint federal/provincial responsibility. In those areas where the AECB actively exercises its authority however, this arrangement has raised an element of uncertainty over the intergovernmental division of management duties. The Nova Scotia Department of the Environment is concerned primarily with three areas of management responsibility for which clarification is required with respect to procedures and/or authority: impact assessment; standard setting and monitoring; and regulatory enforcement.

The Provincial role will be further influenced by the deficiencies or limitations which adhere to the current management regime established by the AECB. Obvious gaps exist in the AECB management process, at the beginning and end of the uranium development process, that is, during the exploration and the post-abandonment stages. To overcome this deficiency during the exploration phase, this Department has incorporated a code of practice for environmental evaluation and pollution control procedures as part of the Provincial exploration licencing process.

Because of uncertainty over the future of the uranium industry in Nova Scotia, the urgency of resolving the post-abandonment management issue is less pressing and immediate than is true of the exploration phase. However, outstanding issues which will require attention include: the allocation of management responsibility; the definition of close-out criteria; and the assignment of financial responsibility for long term monitoring and any required remedial work.

Before any development of the resource begins in this Province, it is very important that these management issues be resolved, i.e. that clear environmental management and regulatory authority be established for all phases of uranium mining and milling; specific procedures be instituted for close-out and abandonment; and a mechanism be put in place to ensure funding for long term waste management.

The Department of the Environment intends to play an important role in protecting the public interest at large and looks forward to any direction and advice that the Inquiry may wish to offer in this matter.

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